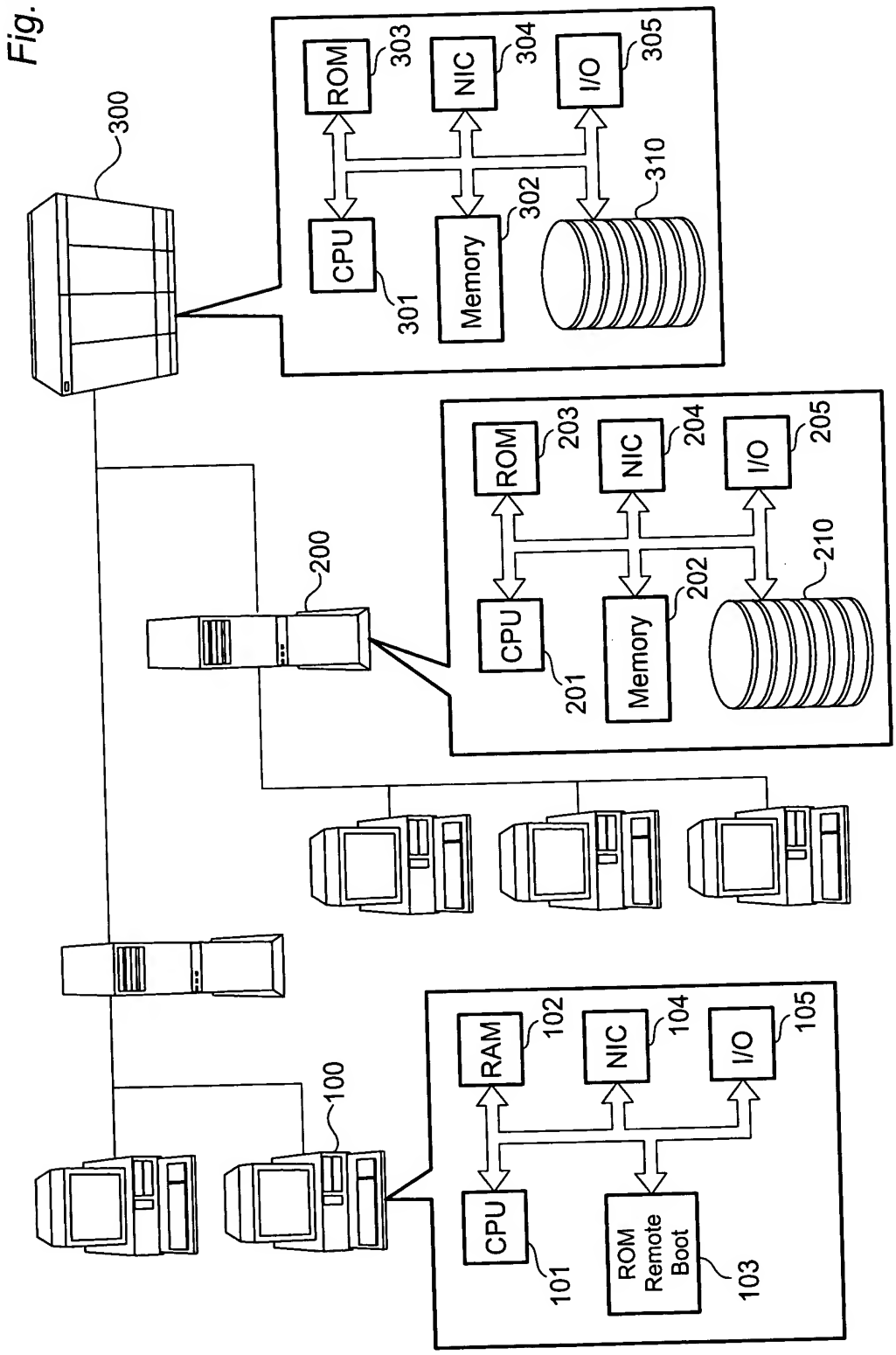
Fig.1


300
ROM
303
NIC
304
I/O
305
CPU
301
Memory
302
310
200
ROM
203
NIC
204
I/O
205
CPU
201
Memory
202
210
100
RAM
102
NIC
104
I/O
105
CPU
101
ROM
Remote
Boot
103

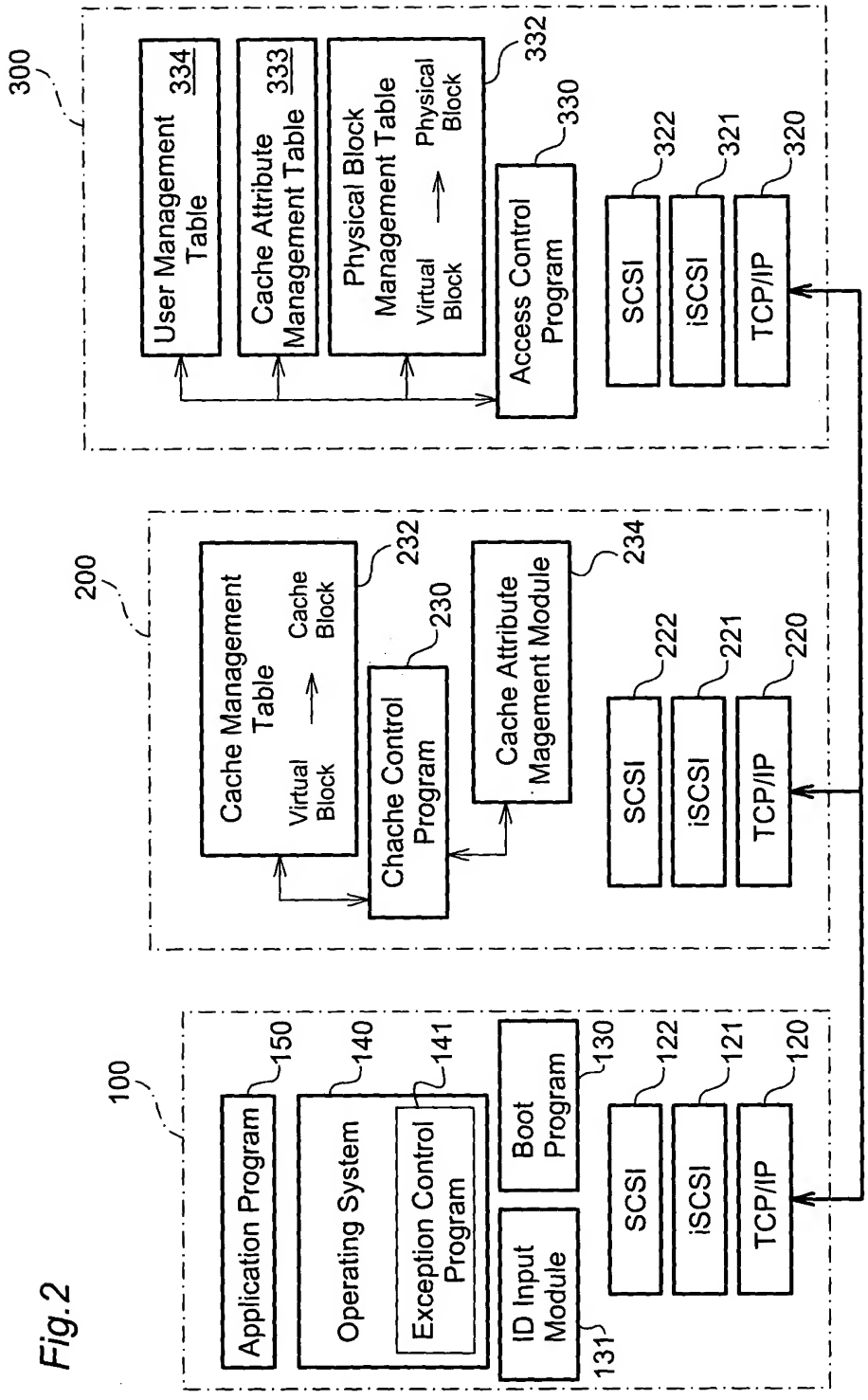

300
User Management Table 334
Cache Attribute Management Table 333
Physical Block Management Table 332
Virtual Block → Physical Block
Access Control Program 330
SCSI 322
iSCSI 321
TCP/IP 320
200
Cache Management Table 232
Virtual Block → Cache Block
Chache Control Program 230
Cache Attribute Magement Module 234
SCSI 222
iSCSI 221
TCP/IP 220
100
Application Program 150
Operating System 140
Exception Control Program 141
Boot Program 130
ID Input Module 131
SCSI 122
iSCSI 121
TCP/IP 120

Fig.2

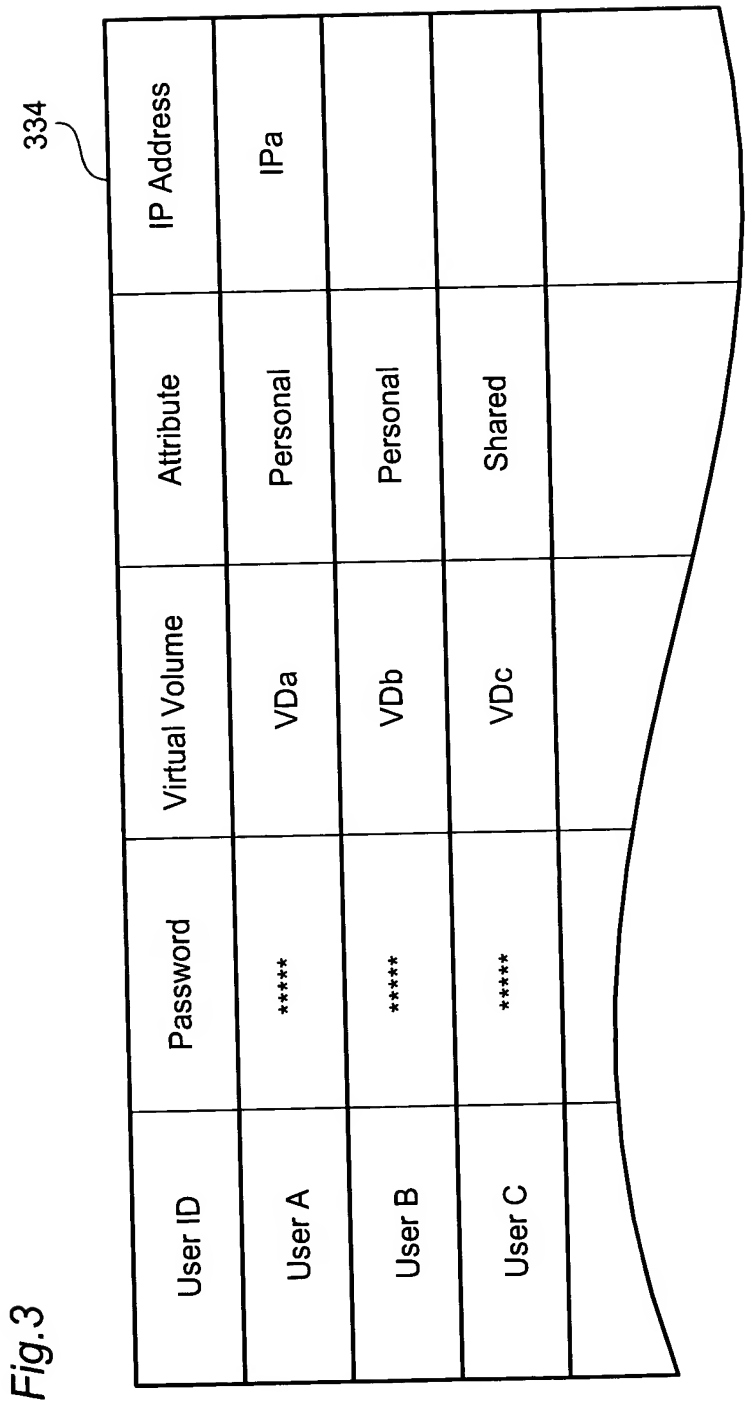
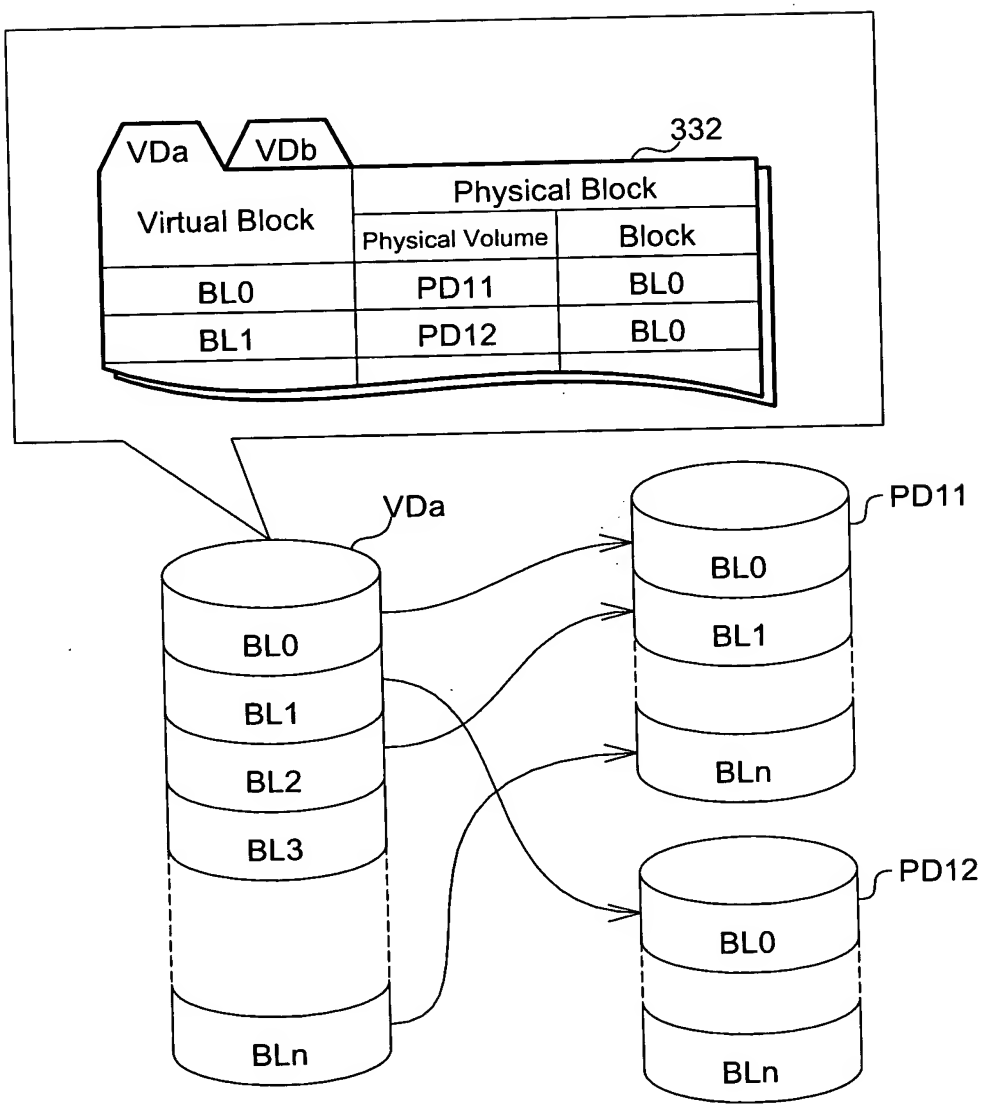

334
User ID
Password
Virtual Volume
Attribute
IP Address
User A
*****
VDa
Personal
IPa
User B
*****
VDb
Personal
User C
*****
VDc
Shared

Fig.3

Fig.4


VDa
VDb
332
Virtual Block
Physical Block
Physical Volume
Block
BL0
PD11
BL0
BL1
PD12
BL0
VDa
BL0
BL1
BL2
BL3
BLn
PD11
BL0
BL1
BLn
PD12
BL0
BLn

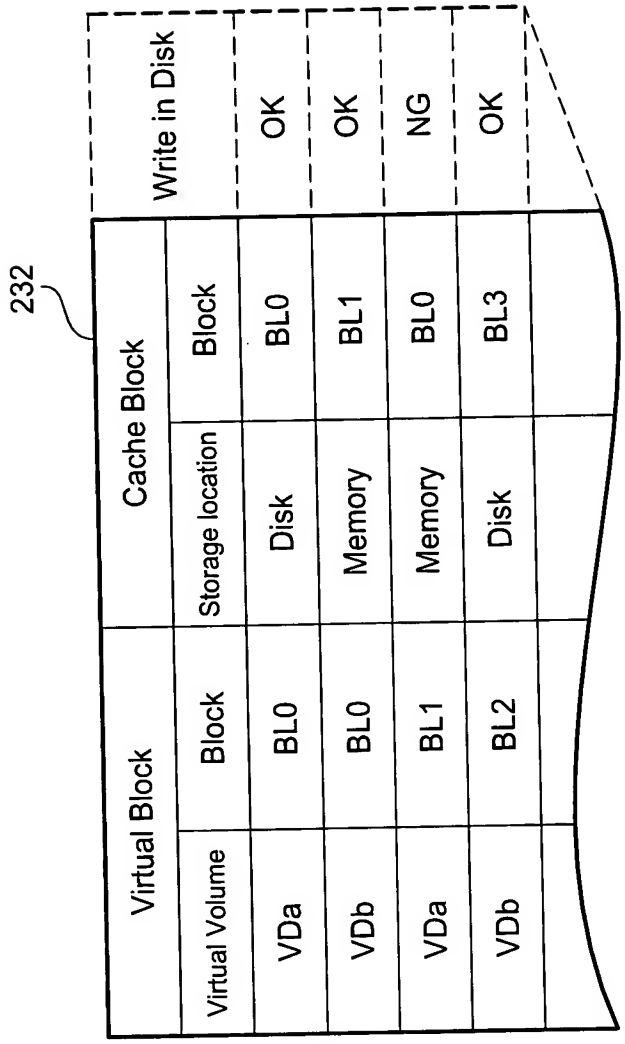

232
Virtual Block
Cache Block
Write in Disk
Virtual Volume
Block
Storage location
Block
VDa
BL0
Disk
BL0
OK
VDb
BL0
Memory
BL1
OK
VDa
BL1
Memory
BL0
NG
VDb
BL2
Disk
BL3
OK

Fig.5

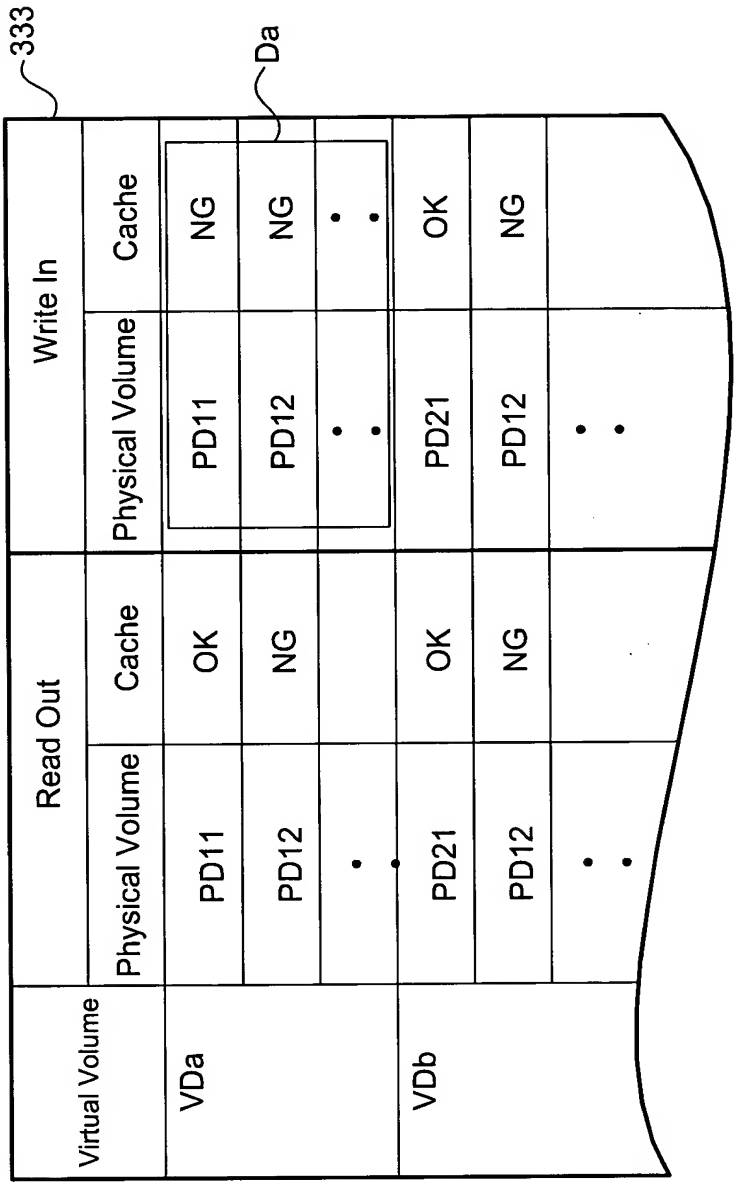

333
Da
Virtual Volume
Read Out
Physical Volume
Cache
Write In
Physical Volume
Cache
VDa
PD11
OK
PD11
NG
PD12
NG
PD12
NG
VDb
PD21
OK
PD21
OK
PD12
NG
PD12
NG

Fig.6

Fig.7

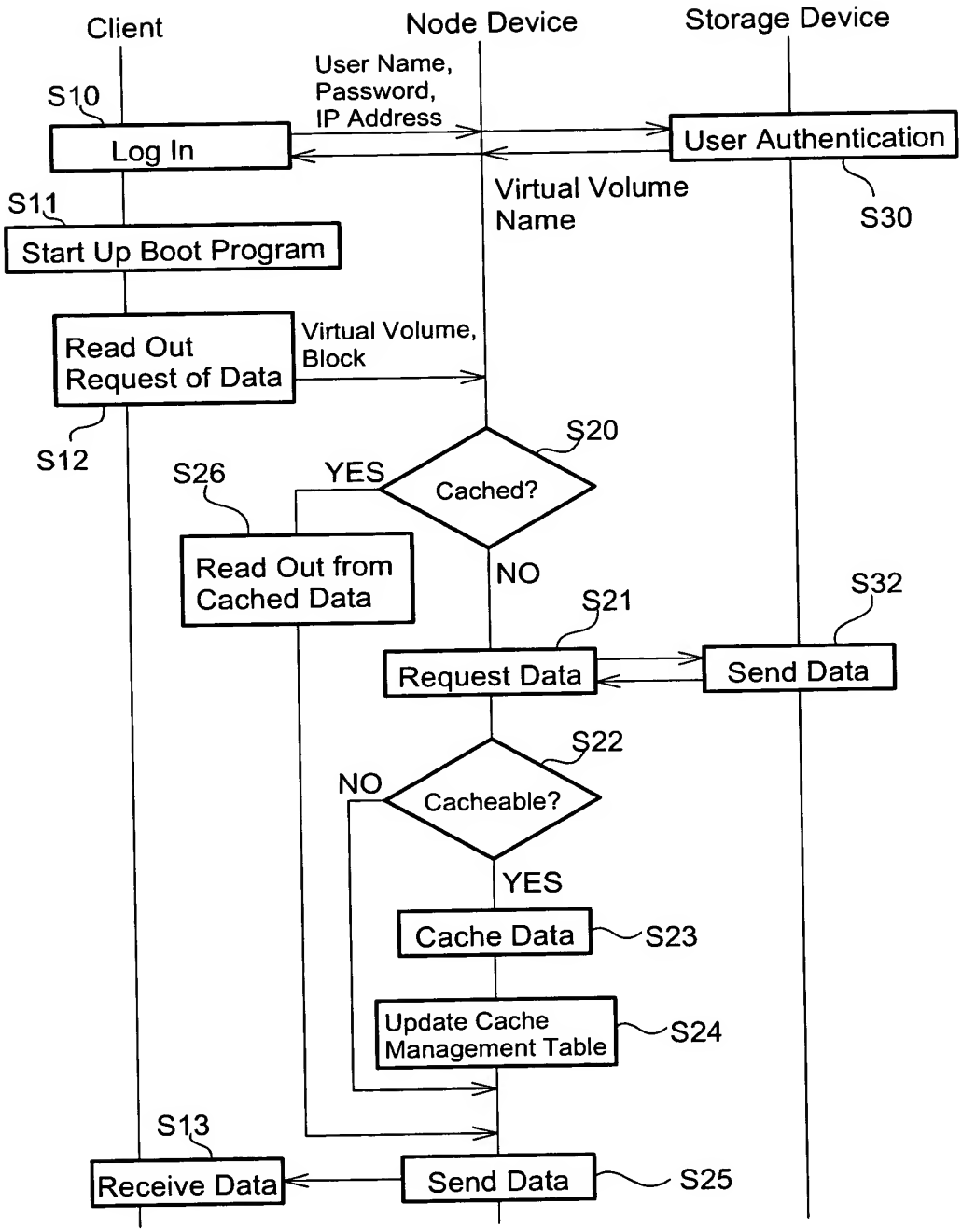

Client
Node Device
Storage Device
S10
User Name,
Password,
IP Address
Log In
User Authentication
Virtual Volume
Name
S30
S11
Start Up Boot Program
Read Out
Request of Data
Virtual Volume,
Block
S12
S20
S26
YES
Cached?
Read Out from
Cached Data
NO
S21
S32
Request Data
Send Data
S22
NO
Cacheable?
YES
Cache Data
S23
Update Cache
Management Table
S24
S13
Receive Data
Send Data
S25

Fig.8

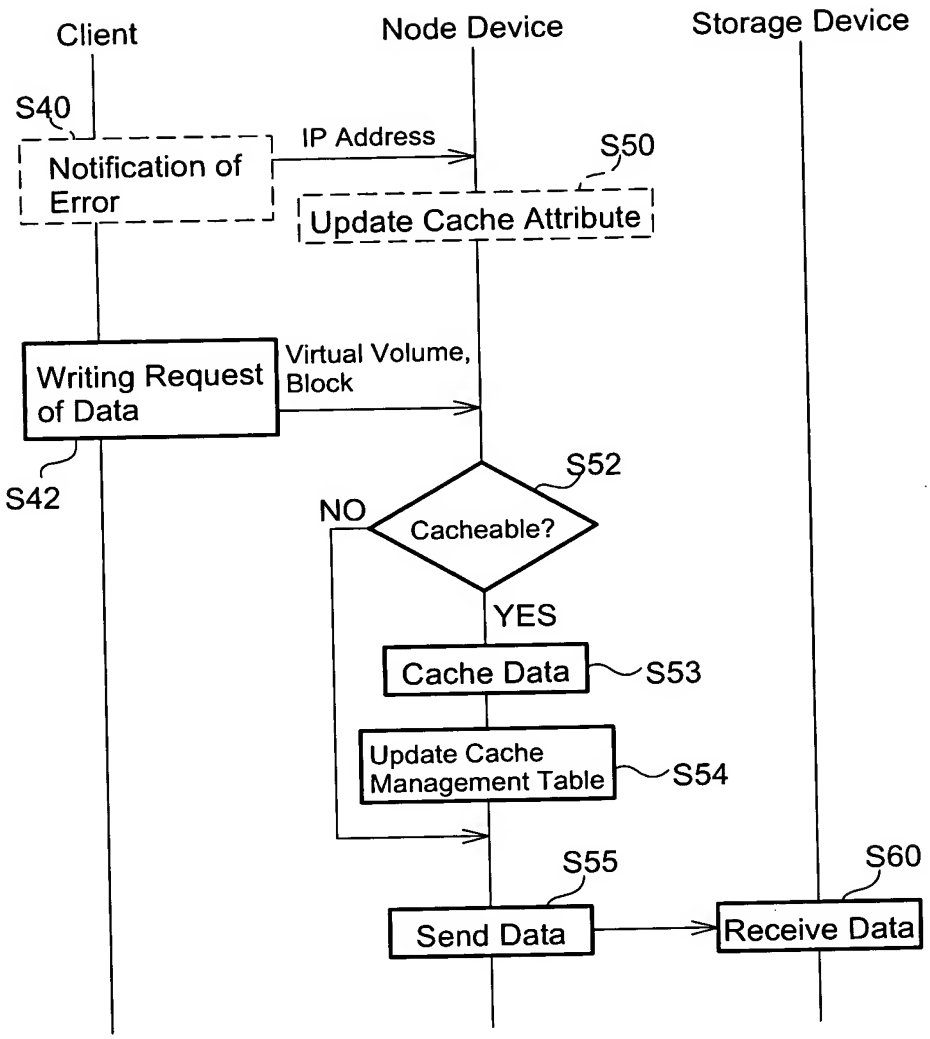

Client
Node Device
Storage Device
S40
Notification of Error
IP Address
S50
Update Cache Attribute
Writing Request of Data
Virtual Volume, Block
S42
S52
NO
Cacheable?
YES
Cache Data
S53
Update Cache Management Table
S54
S55
Send Data
S60
Receive Data

Fig.9

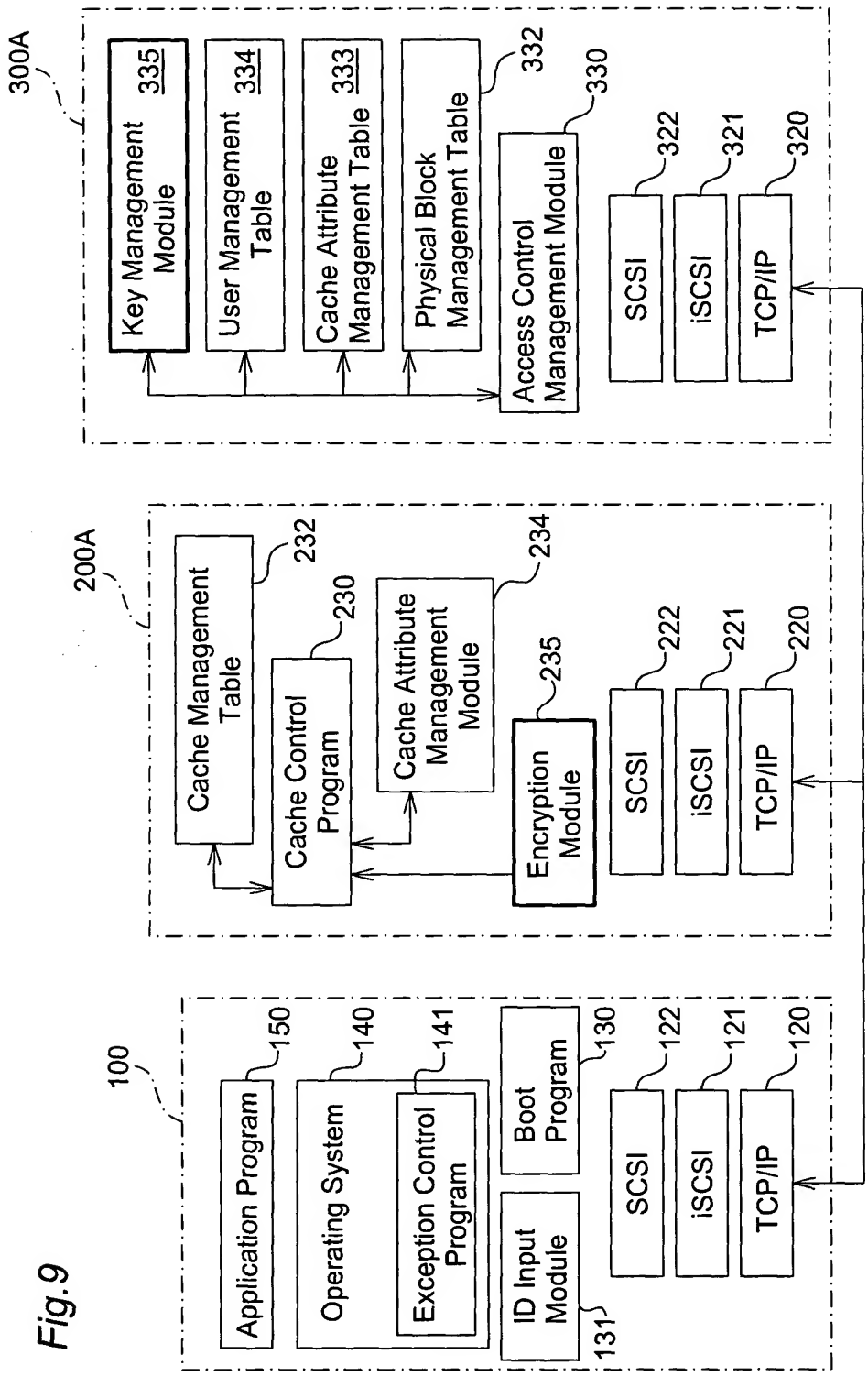

100
Application Program
150
Operating System
140
Exception Control Program
141
ID Input Module
131
Boot Program
130
SCSI
122
iSCSI
121
TCP/IP
120
200A
Cache Management Table
232
Cache Control Program
230
Cache Attribute Management Module
234
Encryption Module
235
SCSI
222
iSCSI
221
TCP/IP
220
300A
Key Management Module
335
User Management Table
334
Cache Attribute Management Table
333
Physical Block Management Table
332
Access Control Management Module
330
SCSI
322
iSCSI
321
TCP/IP
320

Fig.10

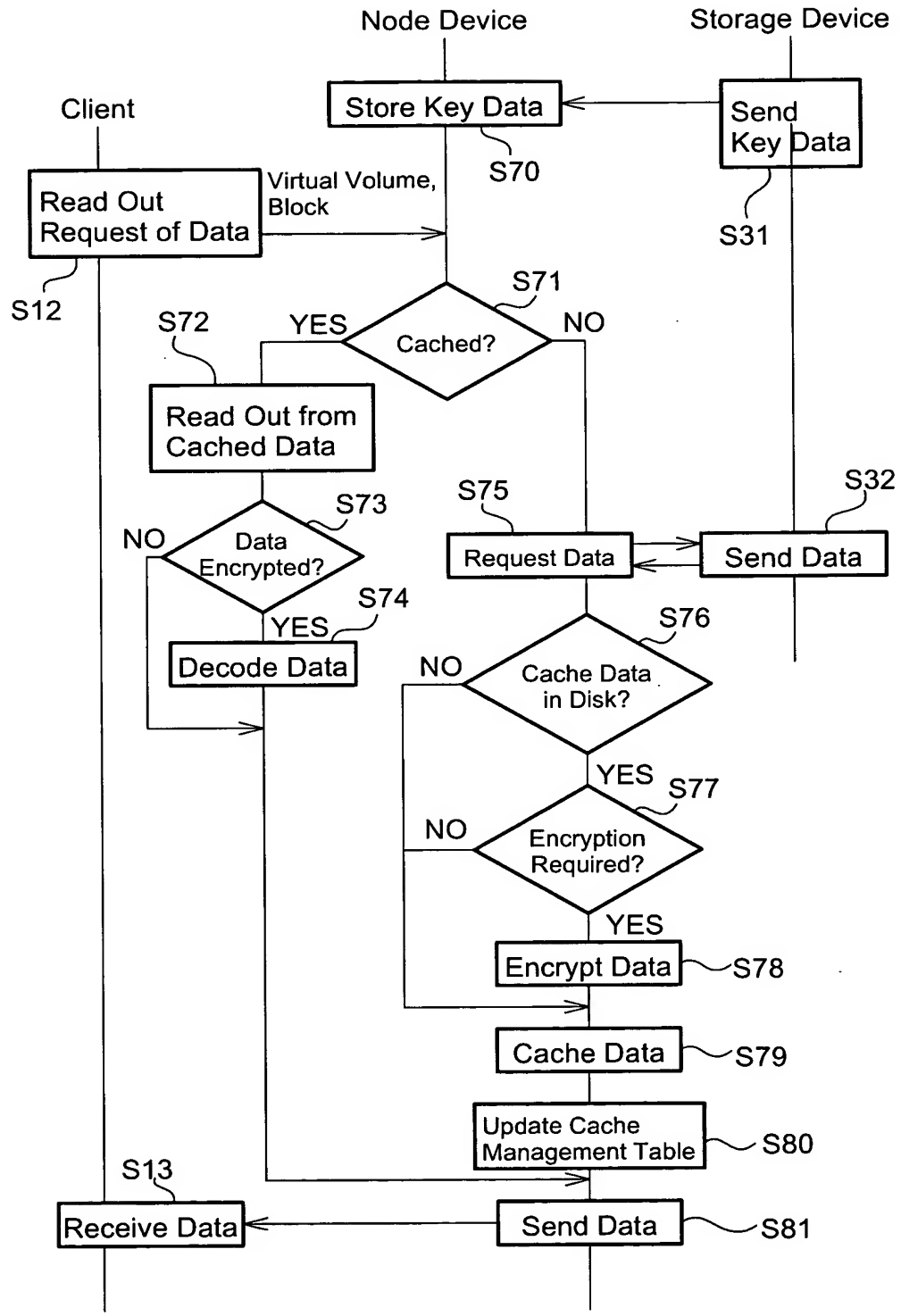

Node Device
Storage Device
Client
Store Key Data
Send Key Data
S70
S31
Read Out Request of Data
Virtual Volume, Block
S12
S71
S72
YES
Cached?
NO
Read Out from Cached Data
S73
S75
S32
NO
Data Encrypted?
Request Data
Send Data
S74
YES
S76
Decode Data
NO
Cache Data in Disk?
YES
S77
NO
Encryption Required?
YES
Encrypt Data
S78
Cache Data
S79
Update Cache Management Table
S80
S13
Receive Data
Send Data
S81

Fig.11

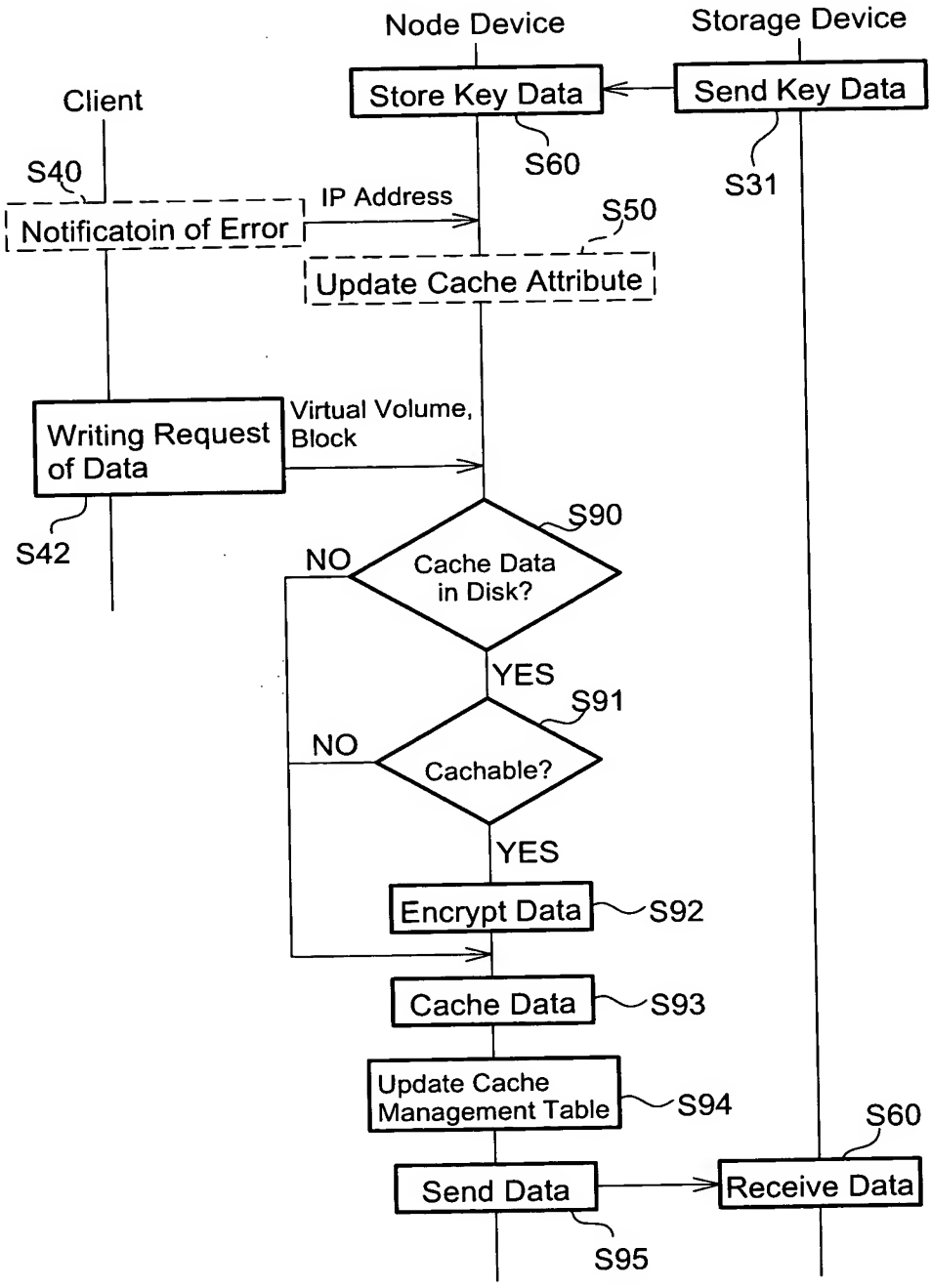

Node Device
Storage Device
Client
Store Key Data
Send Key Data
S60
S31
S40
IP Address
Notificatoin of Error
S50
Update Cache Attribute
Writing Request of Data
Virtual Volume, Block
S42
S90
NO
Cache Data in Disk?
YES
S91
NO
Cachable?
YES
Encrypt Data
S92
Cache Data
S93
Update Cache Management Table
S94
S60
Send Data
Receive Data
S95

Fig.12

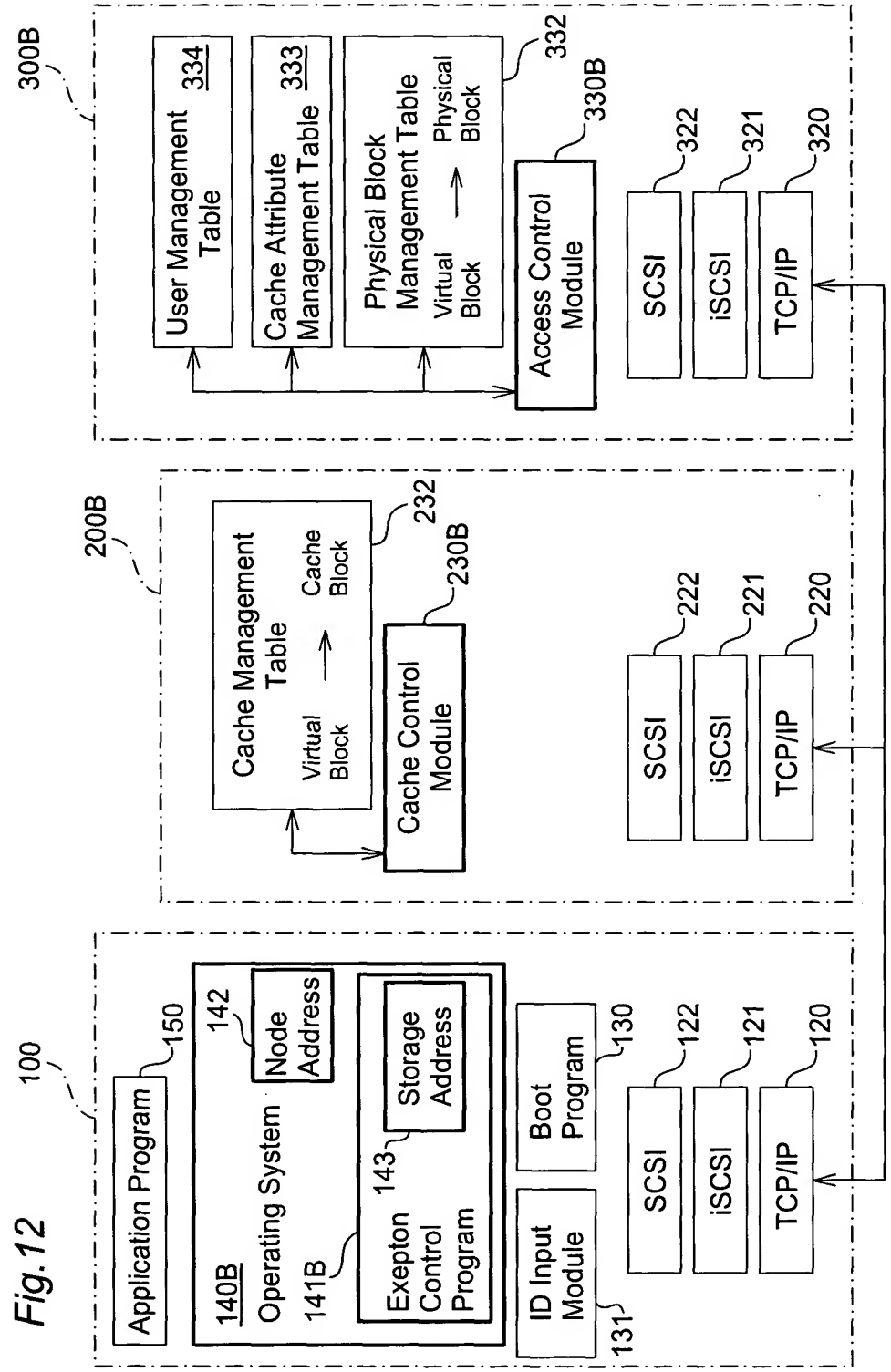

100
Application Program
150
140B
Operating System
142
Node Address
141B
Exepton Control Program
143
Storage Address
ID Input Module
131
Boot Program
130
SCSI
122
iSCSI
121
TCP/IP
120
200B
Cache Management Table
Virtual Block
Cache Block
232
Cache Control Module
230B
SCSI
222
iSCSI
221
TCP/IP
220
300B
User Management Table
334
Cache Attribute Management Table
333
Physical Block Management Table
Virtual Block
Physical Block
332
Access Control Module
330B
SCSI
322
iSCSI
321
TCP/IP
320

Fig.13

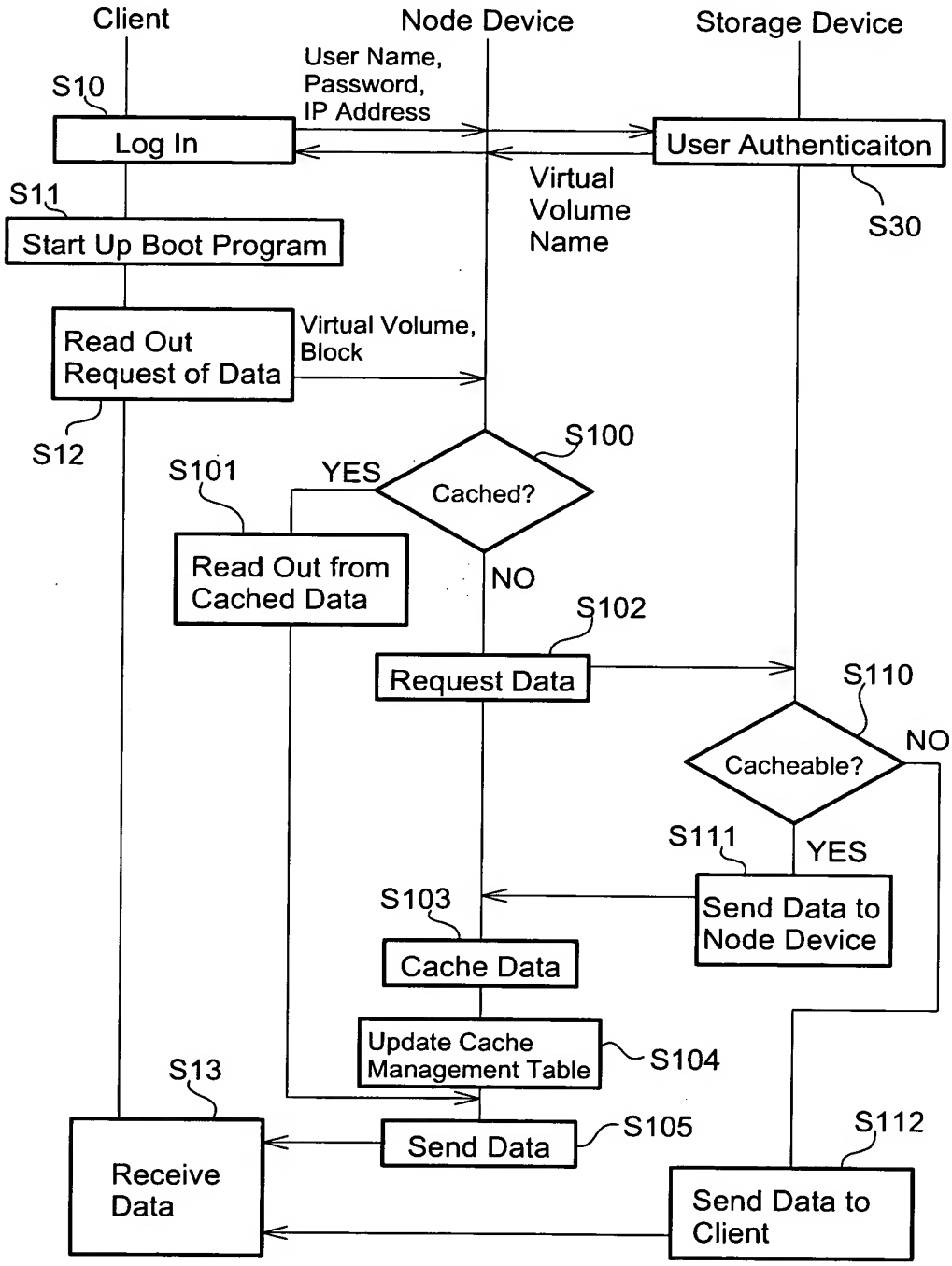
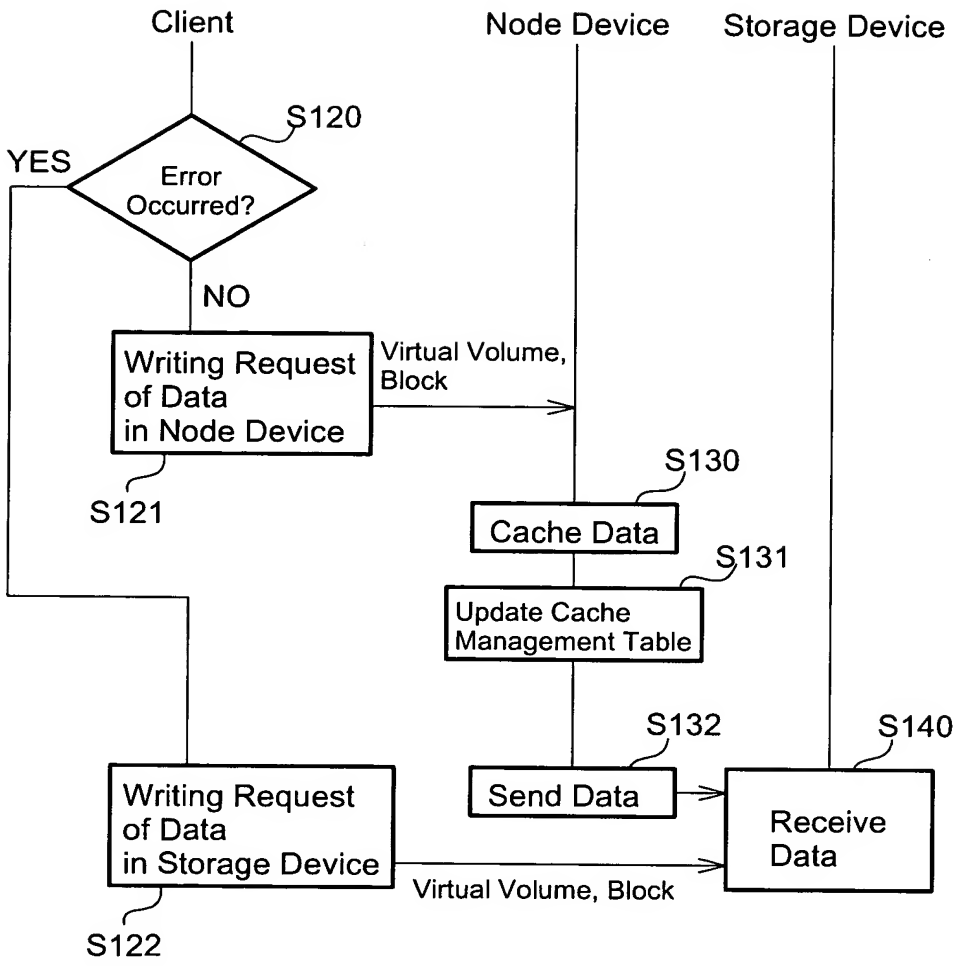

Client
Node Device
Storage Device
S10
User Name,
Password,
IP Address
Log In
User Authenticaiton
Virtual
Volume
Name
S30
S11
Start Up Boot Program
Read Out
Request of Data
Virtual Volume,
Block
S12
S100
S101
YES
Cached?
Read Out from
Cached Data
NO
S102
Request Data
S110
NO
Cacheable?
S111
YES
S103
Send Data to
Node Device
Cache Data
Update Cache
Management Table
S104
S13
S105
S112
Receive
Data
Send Data
Send Data to
Client

Fig.14


Client
Node Device
Storage Device
S120
YES
Error Occurred?
NO
Writing Request of Data in Node Device
Virtual Volume, Block
S121
S130
Cache Data
S131
Update Cache Management Table
S132
S140
Send Data
Receive Data
Writing Request of Data in Storage Device
Virtual Volume, Block
S122